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ABSTRACT

Intended primarily but not solely for use at the postsecondary level, this curriculum guide contains five units on energy efficiency that were designed to be incorporated into an existing program in architectural drafting. The following topics are examined: energy conservation awareness (residential energy use and audit procedures); residential energy consumption (space heating, ventilating, air-conditioning, hot water heating, lighting, and appliances); design considerations for residential energy efficiency (site orientation, building type, room arrangement, location of openings, and building codes); residential construction practices and materials (building and insulating materials, construction methods, infiltration, vapor barriers, and moisture control); and energy saving devices and methods (ventilation, lighting, solar systems, stoves and fireplaces, wind generators, heat sinks, and moveable insulation). Covered in each lesson are unit rationale, necessary advanced preparation, anticipated instructional time, guidelines for implementing the unit, unit activities, and unit references. (MN)

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Energy Efficiency
For
Architectural Drafting Instructors

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CE 033 352

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PREFACE

This curriculum guide was produced by the Nebraska Energy Office in a cooperative effort with the Nebraska State Department of Education. These organizations are dedicated to the development of quality educational materials that promote wise energy management.

The following individuals assisted in the production of these materials:

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These materials will be piloted during the 1981-1982 school year, revised, and subsequently made available statewide for the 1982-1983 academic year.

All inquiries, suggestions, or comments regarding this curriculum guide should be directed to:

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INTRODUCTION

This curriculum guide contains five units that were designed to be incorporated into an existing program of Architectural Drafting. The units also form the basis for initiating a separate course of instruction. The material is primarily intended for use at the postsecondary level. A well equipped secondary instructor, however, will also find the information useful.

The five units may be taught independently or collectively depending on the needs of the instructor at any single institution. The content of these units has been written and organized into an outline format. Each unit outline, in order to facilitate articulation between units, consists of the following sections: rationale, advanced preparation, anticipated instructional time, unit guide, activities, and references.

The degree of coverage depth, instructional time, and evaluation of student performance are left at the discretion of the individual instructor. Suggested activities are included but are by no means comprehensive. Instructors should feel free to add, delete, or substitute activities, references, and audiovisual materials. The Nebraska Energy Office encourages innovation to best suit the needs of the individual instructor.

The overall objective of this curriculum guide is to provide the Architectural Drafting instructors in Nebraska with a format to achieve continuity in their approach to teaching energy efficiency for Architectural Drafting.

COURSE RATIONALE

This course is designed to promote the understanding and application of some important energy conservation practices in architectural drafting. It is our intent to provide the student with sufficient information to expand his/her working knowledge of energy efficient residential construction. A thorough understanding of the principles discussed in the units to follow, however, will maximize a student's knowledge of energy efficiency.

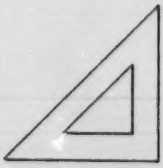
1. Energy Conservation Awareness - presents an overview of residential energy use and audit procedures.

2. Residential Energy Consumption - provides information on space heating, ventilating, air-conditioning, hot water heating, lighting, and appliances.

3. Design Considerations for Residential Energy Efficiency - deals with site orientation, building type, room arrangement, location of openings, and building codes.

4. Residential Construction Practices and Materials - includes building and insulating materials, construction methods, infiltration, vapor barriers and moisture control.

5. Energy Saving Devices and Methods - familiarization with ventilation, lighting, solar systems, stoves and fireplaces, wind generators, heat sinks, moveable insulation, etc.



UNIT I

ENERGY CONSERVATION AWARENESS

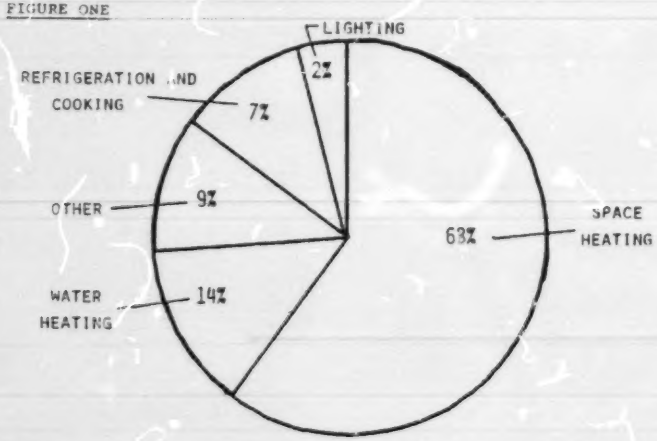
RATIONALE

Commercial buildings and residential dwellings consume one-third of all energy used in this country. It is the responsibility of the architectural designer and drafter to consider planning or retrofitting a building for energy efficiency.

Until 1973, most buildings in America were designed and built using "cheap energy" as a criteria. Now, "expensive and scarce energy" has become the design criteria. New buildings must be made energy efficient and existing buildings must be retrofitted to reduce energy waste.

The figure below indicates the distribution of energy consumption in U.S. homes. (D.O.E. 1977)

FIGURE ONE



This unit is designed to identify potential locations of residential energy loss and establish criteria for their measurement.

ADVANCED PREPARATION

It is recommended that the following publications be obtained and thoroughly reviewed prior to teaching this unit:

1. Nebraska Energy Saving Manual - from the Nebraska Energy Office.
2. Energy Saving Packet - from the Nebraska Energy Office.
3. Manual J. Load Calculation - from the Air Conditioning Contractors Association.

ANTICIPATED INSTRUCTIONAL TIME

1-3 weeks

UNIT GUIDE

1. ENERGY CONSUMPTION RECORDS

   It is important to determine how much energy is being used in an existing building prior to recommending a methodology for reducing energy consumption.

   A. Obtain monthly data from owner records or utility companies.
   (SEE FIGURE TWO.)

FIGURE TWO

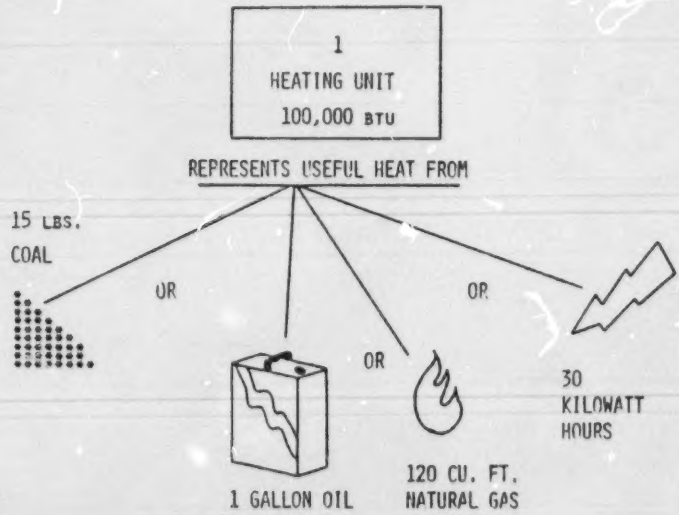
ENERGY CONSUMPTION RECORD

Year: _____

MONTH	ELECTRICITY		FUEL CHECK: GAS OIL COAL	
	KWH	COST	QUANTITY	COST
JANUARY				
FEBRUARY				
MARCH				
APRIL				
MAY				
JUNE				
JULY				
AUGUST				
SEPTEMBER				
OCTOBER				
NOVEMBER				
DECEMBER				

B. Convert energy consumption figures into heating units and cost per heating unit. (Apply consumer price of fuel type per heating unit.)
Example: Natural Gas = 39¢/heating unit.

FIGURE THREE



A BTU is approximately equal to the amount of heat given off when one wooden match is burned completely. Specifically, a BTU (British Thermal Unit) is the amount of energy required to raise one pound of water one degree Fahrenheit.

1 heating unit = 1 therm = 100,000 BTU

FIGURE FOUR

CONVERTING ANNUAL ENERGY CONSUMPTION DATA INTO HEATING UNITS

	QUANTITY		HEATING UNITS
1.	_____ ELECTRICITY	KWH / 30 =	_____
2.	_____ NATURAL GAS	MCF* / .12 =	_____
3.	_____ OTHER GAS**	GAL / 1.3 =	_____
4.	_____ OIL	GAL / 1.0 =	_____
5.	_____ COAL	LBS / 15 =	_____
6.	TOTAL HEATING UNITS	=	_____

* THOUSAND CUBIC FEET

** PROPANE, LPG, OR BOTTLED GAS

2. INSPECTION

The second phase in reducing energy consumption, after determining total energy use/cost, is to ascertain all possible locations for energy loss. The following is a checklist of items to consider when designing or retrofitting a building for energy efficiency.

FIGURE FIVE

Building Shell	Yes	No	NA		Yes	No	NA
1. Are storm windows and storm doors installed?				9. Has a clock thermostat been installed to reduce, automatically, evening temperatures?			
2. Are window panes and frames properly caulked? Do windows open for natural ventilation?				10. In colder climates, is window space on the north side of the house at a minimum?			
3. Are exterior doors weatherstripped? Are door frames caulked?				11. Is the home efficiently shaped to limit heat loss, avoiding L-, T-, and H-shaped configurations?			
4. Are ceilings and walls insulated to the highest level recommended for your geographic location? graphic location?				12. Does the house have an overhang for the south wall which will protect it from summer sun but allow exposure to winter sun?			
5. Does the home have a vapor barrier in the walls to prevent water vapor from passing through and condensing into the insulation?				13. Does the fireplace have a heat exchanger to collect unused heat?			
6. Are floors insulated over unheated basements, crawl spaces and garages?				14. Is the fireplace a high-efficiency type with a tight damper?			
7. Do basement walls contain 2" x 2" furring with R-7 insulation?				15. Is fluorescent rather than incandescent lighting used in the kitchen and bathroom?			
8. Have you considered 6" walls with studs on 24" centers to allow maximum space for insulation?				16. Are outdoor gas lamps essential for safety (not merely decorative)?			
				17. Does the landscaping shade the house in summer and let in winter sun?			
Appliances							
1. Do appliances have the highest Energy Efficiency Rating?				2. Is the hot water heater well insulated? Is the water temperature at a reasonably low level?			

Heating, Ventilating, and Air Conditioning	Yes	No	NA		Yes	No	NA
1. Are hot water pipes or hot air ducts insulated in unheated passages?				8. Is cooling equipment the smallest size possible to do the job adequately?			
2. Are air leaks in ductwork sealed?				9. Is the heating system the most efficient? Is it the appropriate size? Over-sized systems waste a great deal of energy. Is the oil furnace serviced regularly?			
3. Are exposed hot water pipes and hot water storage tanks insulated to reduce heat loss?				10. Do heating and cooling systems provide for continuous fan operation which often provides comfort without using the full system capacity?			
4. Have you considered a heat-recovery pipe which preheats outside air with exhaust air from the ventilation system?				11. Does the attic have 1 square foot of ventilation for each 300 square feet of ceiling? (This reduces the air-conditioning load, and should be done even with insulation having a vapor barrier in the ceiling).			
5. Are window or whole-house ventilating fans adequate for comfort?				12. Have fuel costs and supplies been evaluated to select equipment and fuel on a lifetime cost efficiency basis?			
6. If home has air-conditioning units or a central compressor, are they shaded from the sun to increase efficiency and reduce energy use?							
7. Does cooling equipment have the highest Energy Efficiency Rating?							

3. LIVING HABITS

Two families living in identical dwellings can realize totally different patterns of energy consumption for numerous reasons (other than being unnecessarily wasteful). Don't jump to conclusions! The following factors should be considered:

A. Small children
B. Elderly or invalid residents
C. Special building use
D. Lifestyle

4. BUILDING ENERGY AUDIT

A building energy audit assesses energy use patterns, inspects the building's physical and mechanical systems, and provides recommendations for measures that can be undertaken to improve the overall energy efficiency of the structure being examined. The recommendations frequently include, but are not limited to, no-cost/low-cost items that yield a substantial energy savings. More costly measures, including retrofitting, will save energy but should be considered only when the cost/benefit ratio yields substantial energy savings in a reasonable payback period.

Examples:

No Cost	Low Cost	Investments
-Reduced lighting	-Caulking	-Double-paned glass
-Shutting lights off in unoccupied spaces	-Weatherstripping	-Heating unit replacement
-Maintaining voluntary temperature restrictions	-Showerhead flow restrictors	-Solar panels

Building audits involve converting all heating units (from all energy sources) into BTUs and determining, by inspection, where energy heat losses occur. The Nebraska Energy Saving Manual and Manual J. Load Calculation contain all information necessary to complete an energy audit.

UNIT ACTIVITIES

1. The student should complete an energy audit of an actual building or from a building plan.

UNIT REFERENCES

The following titles can be obtained from the:
Nebraska Energy Office
P.O. Box 95085
Lincoln, NE 68509

1. Nebraska Energy Saving Manual (50¢ per copy)
2. Energy - Saving Checklist for Home Builders, Buyers, and Owners.
3. Providing for Energy Efficiency in Homes and Small Buildings

Media (from the Nebraska Energy Office)

Slide Sets:
1. Save Energy - Save Money
2. The Ins and Outs of Insulation
3. The Home Energy Check
4. Weatherization Slide Set

Other References:

1. Manual J. Load Calculation by the Air Conditioning Contractors Association.
2. In the Bank or Up The Chimney by the U.S. Dept. of Housing and Urban Development (HUD).

UNIT II

RESIDENTIAL ENERGY CONSUMPTION

RATIONALE

The United States consumes several times more energy on a per capita basis than any other country in the world. Americans, in fact, have more than doubled their consumption of energy in the past 25 years. (See FIGURE SIX.) Much of this consumption, however, is wasteful and unnecessary.

Residential energy represents an area of consumption over which we, as individuals, do have some control. Several energy consuming devices, found in our homes today, will be identified in this unit. It is the purpose of this unit, to identify these energy consuming devices and suggest methods for reducing unnecessary energy waste in each device.

ADVANCED PREPARATION

It is recommended that all publications related to residential energy consumption (i.e. - heating, cooling, appliances, etc.) be obtained from the Nebraska Energy Office or local utility company prior to beginning this unit. Suggested titles are listed at the end of this unit.

ANTICIPATED INSTRUCTIONAL TIME

1-3 Days

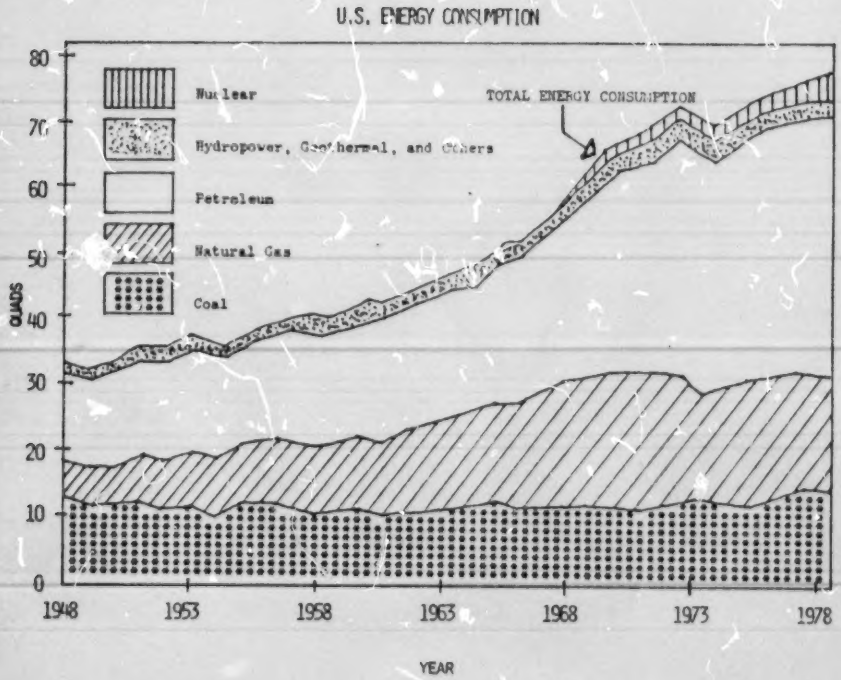
UNIT GUIDE

1. SPACE HEATING (68% of home energy use)

A. Fuels are consumed in the mechanical equipment to provide heat.

1. Mechanical equipment types (forced air, heat pumps)
2. Operating efficiency of mechanical equipment, etc.
3. Energy source utilized
   a. Coal
   b. Electricity
   c. Fuel oil

FIGURE SIX



SOURCE: ENERGY IN TRANSITION, 1985 - 2010

B. Heat loss calculations

2. SPACE COOLING (5% of home energy use)

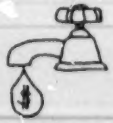
A. Electricity is the most common energy source
   1. What alternatives exist?

B. Mechanical equipment types
   1. Air conditioners.
   2. Heat Pumps - Cooling Mode.
   3. Ventilation systems.

C. Operating efficiencies
   1. Energy efficiency ratios.
   2. Proper sizing.
   3. Heat loss calculations.

3. PLUMBING AND WATER HEATING (14% of home energy use)

A. Energy used to supply water.
B. Water heating equipment.
C. Hot water consumption per year.



4. LIGHTING (2% of home energy use)

A. Artificial lighting types (incandescent, fluorescent, H.I.D.)
B. Power consumption of different lighting types
C. Efficiency of light versus power

5. APPLIANCES AND EQUIPMENT (9% of home energy use)

A. Major appliances that consume a great deal of energy include:
   1. Room air conditioners
   2. Clothes washers and dryers
   3. Dishwashers
   4. Refrigerators and freezers
   5. Water heaters
   6. Kitchen appliances
   7. Housewares (clock, etc.)
   8. Home entertainment systems
   9. Heating and cooling (fans, heater, etc.) systems
   10. Health and beauty aids (hair dryer, sun lamp, etc.)

6. PRACTICING RESIDENTIAL ENERGY CONSERVATION

A. We can cut our energy use and help control living costs by making our homes energy efficient.

1. Heating:

-clean entire system
-locate thermostat properly
-set thermostat at 65°F (day)
-set thermostat at 55°F (night)
-use electric blankets
-close off unheated rooms
-control humidity
-use drapes and other moveable insulation
-use fireplaces sparingly

2. Cooling:

-well vented attic
-adjust vents upward
-reduce lighting
-close drapes to avoid solar gain
-set thermostat at 78°F
-use fans instead of air-conditioning
-use exhaust fans for humidity and odor control only
-use free air flow outlets

3. Lighting:

-make good use of natural light
-paint walls a light color
-avoid excessive lighting
-use fluorescent lamps
-install variable light controls
-turn off unnecessary lights
-install automatic controls on all outside lights
-select fixtures with good reflective qualities

4. Appliances (See Figure Seven)

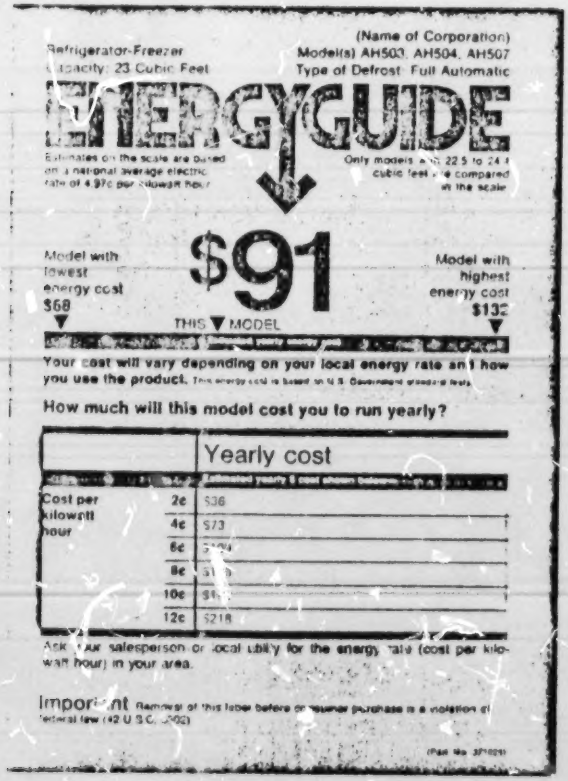
-baking (use microwave ovens)
-cooking
-dishwashing
-refrigerator/freezer
-gas ranges with electronic ignition (saves 1/3)
-ironing
-bathroom fixtures
-hot water heaters
-federally required labels

(NOTE: The publications "Tips for Energy Savers" and "Appliance Labeling" are helpful for this section.)

5. Plumbing:

-place water heater in close proximity to major area of use
-install aerators on all faucets
-install a shower in the bathroom

FIGURE SEVEN


Refrigerator-Freezer
Capacity: 23 Cubic Feet
(Name of Corporation)
Model(s) AH503, AH504, AH507
Type of Defrost: Full Automatic
ENERGYGUIDE
Estimates on the scale are based on a national average electric rate of 4.97¢ per kilowatt hour
Only models with 22.5 to 24 cubic feet are compared on the scale
Model with lowest energy cost
$68
$91
THIS MODEL
Model with highest energy cost
$132
Your cost will vary depending on your local energy rate and how you use the product.
How much will this model cost you to run yearly?
Yearly cost
Cost per kilowatt hour
2¢ $36
4¢ $73
6¢
8¢
10¢
12¢ $218
Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.
Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302)

UNIT ACTIVITIES

1. The student should research and select HVAC, lighting, hot water systems, and appliances for a typical residence, using reference material and appropriate available criteria.

UNIT REFERENCES

The following titles can be obtained from the:
Nebraska Energy Office
P.O. Box 95085
Lincoln, NE 68509

1. Appliance Labeling
2. Tips for Energy Savers
3. The Nebraska Energy Saving Manual (50¢ per book)
4. Appliance Labeling Resource Kit

Media

16mm films: "Project Conserve - Saving Home Energy" (20 minutes)
"Saving Energy at Home" (13 minutes)

Slide Set: "Save Energy - Save Money"

Other References

1. ASHRAE - Standards Manual
2. ACCA - Manual K. Equipment Selection System Design
3. Consumer Reports

UNIT III

DESIGN CONSIDERATIONS FOR ENERGY EFFICIENCY

RATIONALE

There have been a variety of "energy saving homes" built in recent years. Many have been constructed under the sponsorship of utility companies, building manufacturers or universities. These experimental homes have demonstrated the value of good planning to save energy.

This unit presents some important features that need to be considered when planning a home. These features include: site consideration, orientation, type of construction, room arrangement, treatment of openings, and building codes.

ADVANCED PREPARATION

It is recommended the publications "Planning an Energy Efficient Home", "Nebraska Building Energy Conservation Standard" and "Landscaping and Climate Around Your Home", be obtained from the Nebraska Energy Office prior to the beginning of this unit.

ANTICIPATED INSTRUCTIONAL TIME

1-3 weeks

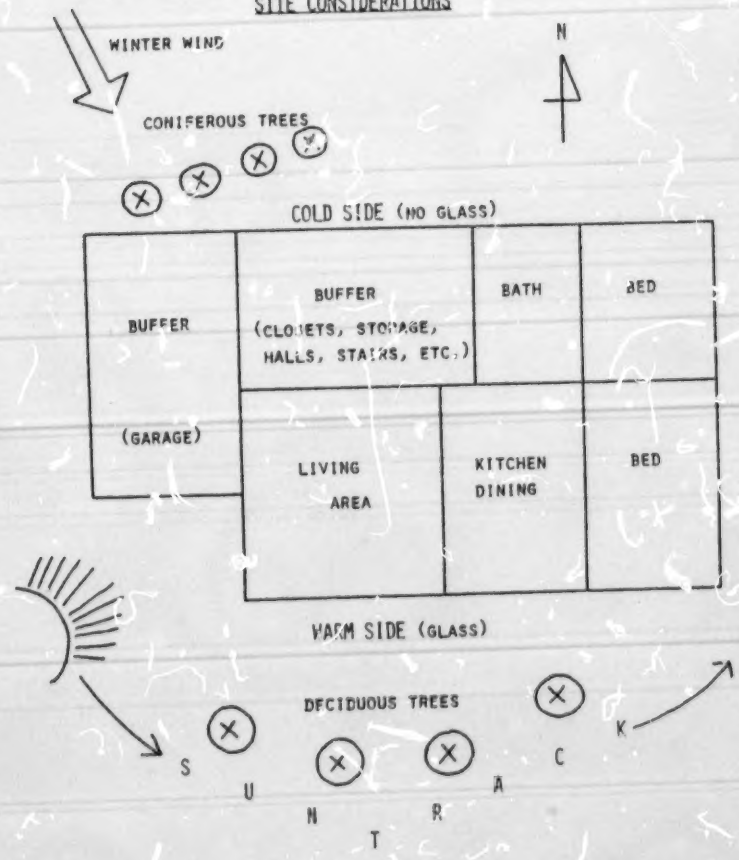
UNIT GUIDE

1. SITE CONSIDERATIONS (See FIGURE EIGHT)

   A. Location and orientation affect energy consumption patterns both in winter and summer seasons. Consider the following:
      1. The angle of the sun during both winter and summer seasons.
      2. Hilltops, ridges, and higher elevations are more exposed to the wind. Consequently, homes will be colder in the winter, and cooler in the summer.
      3. Coniferous trees provide excellent wind screening.
      4. Orientation of the home depends upon the climate in which it's being built.
         a. cold zones - orient the home facing south and build into a northern or western slope.
         b. temperate zones - orient the home to balance the effects of winter wind and summer heat.
         c. hot/humid zones - orient the home to provide maximum access to air currents (for ventilation purposes).

FIGURE EIGHT

SITE CONSIDERATIONS



B. Subsoil conditions must be taken into account:
   1. Water table depth
   2. Soil bearing capacity
   3. Drainage

2. ENERGY EFFICIENT HOMES

An energy efficient home is one that provides its occupants with requisite space, comfort, and service while maximizing the efficient use of energy. The following must be considered:

A. Building Type - as it relates to grade. Is the grade above, below, or bermed?

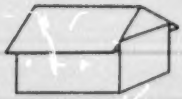
B. Structural System - frame, brick, etc.

C. Is the building new, a remodel, or being retrofitted?

D. Foundation - the type of foundation will determine the location and type of insulation required.
   1. Isolated piers and post footings.
   2. Continuous footings and foundations.
   3. Slab on grade.

E. Exterior walls - should serve two functions:
   1. Retention of heat (winter).
   2. Prevent unwanted solar heat gain (summer).

F. Roofs - flat or pitched.
   1. Flat roofs are not recommended for cold, snowy regions.
   2. Pitched roofs are best for shedding water and snow.
   3. The pitched roof is an important energy efficiency feature because:
      a. The roof overhang will protect windows from summer solar gain.
      b. Roof color will reflect or absorb solar gain.



3. FLOOR PLANS

A. Systematic diagrams should contain appropriate site considerations.

B. Plan room arrangements and circulation (with appropriate site considerations).
   1. Rooms with frequent use - warm (south) side of the plan. (i.e. living and dining areas)
   2. Rooms with infrequent use - cold (north) side of the plan. (i.e. bedroom and bath areas)
   3. Buffer areas such as the garage can be placed toward the north (or west) side of the plan.

4. WINDOWS AND DOORS

Although windows and doors allow heat loss (winter) or gain (summer), they are necessary. Their efficiency can be improved through proper location and construction.

A. Windows - must be planned for optimum light entry, beneficial solar gain, and aesthetic value. Provisions should be planned to accommodate:
   1. Storm windows
   2. Ventilation (to reduce cooling needs)
   3. Exterior shutters (to retain space heating and cooling)
   4. Multiple glazing (where cost/effective)

B. Doors - placed on the south or southeast whenever possible. Provisions should be planned to accommodate:
   1. Storm doors
   2. Overhangs, air-locks, and planters
   3. Properly located secondary entrances.

(NOTE: Sliding glass doors should be avoided as well as the installation of unnecessary secondary entrances.)

5. BUILDING CODES

All applicable building codes must be followed and complied with.

A. Use the most STRINGENT code affecting your locality.
   1. Federal codes cover all FHA, HUD loans, etc.
   2. State codes cover minimum lighting and thermal energy standards where a local code does not exist.
   3. County codes (if in existence)
   4. Local codes must be complied with (if in existence).
   5. Zoning regulations

UNIT ACTIVITIES

1. The student should develop a set of preliminary drawings (including a floor plan and room arrangements), to accommodate the following criteria:

   A. Site considerations
   B. Building type
   C. Structural System (etc.)

2. The student should modify all preliminary plans to include as many energy efficient techniques as possible. (Use the Unit Guide for suggestions.)

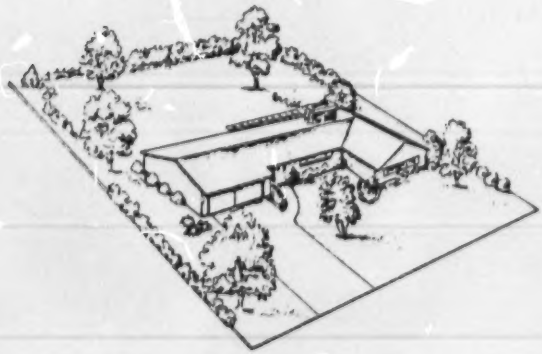
UNIT REFERENCES

The following titles can be obtained from the:
Nebraska Energy Office
P.O. Box 95085
Lincoln, NE 68509

1. Planning an Energy Efficient Home
2. Landscaping and Climate Around Your House
3. Nebraska Building Energy Conservation Standards
4. Tips for Energy Savers

Other References:

1. ASHRAE : Energy Conservation in New Building Design



UNIT IV

RESIDENTIAL CONSTRUCTION PRACTICES AND MATERIALS

RATIONALE

The purpose of this unit is to introduce building practices and materials. The student should now be able to incorporate energy efficient techniques (upon the completion of Units I-III) into a normal course of instruction. The student will also be introduced to the topic of insulation: the amount to use and its placement.

ADVANCED PREPARATION

Sucessful completion of the first three units.

ANTICIPATED INSTRUCTIONAL TIME

1-3 weeks

UNIT GUIDE

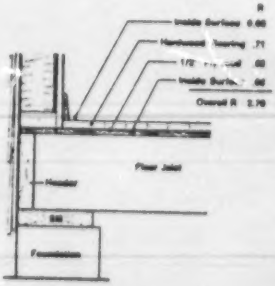
1. BUILDING MATERIALS

   A. Footings
      1. Concrete
      2. Crushed rock (gravel, under preserved wood)

   B. Foundations
      1. Poured concrete
      2. Concrete masonry units
      3. Treated wood

   C. Floors
      1. Wood
         a. Basement
         b. Crawl space
      2. Concrete slab on grade
      3. Metal joist
         a. Concrete deck
         b. Wood deck

   D. Exterior walls
      1. Wood studs
      2. Metal studs
      3. Post and beam
      4. Concrete masonry units
      5. Concrete
         a. Poured
         b. Precast
      6. Solid masonry
      7. Masonry veneer



E. Roof System
   1. Structural frame
      a. Wood (conventional rafters, trussed rafters, beam)
      b. Metal
   2. Sheathing (decking)
      a. Wood
      b. Plywood
      c. Structural panels

2. INSULATION MATERIALS

(NOTE: Remember to use the most STRINGENT existing building code; local, county, state, or federal codes.)

- Determine the most cost/effective required R-value.
- Don't insulate over eave vents, recessed lighting fixtures, or other heat-producing equipment on the attic floor.
- Insulate floors over unheated spaces (such as crawl spaces, garages, and ductwork.)

A. Foundations
   1. Rigid
   2. Pour-in
   3. Batt (wood foundation)

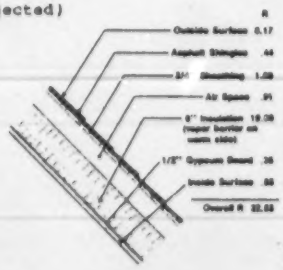
B. Floors
   1. Batt
   2. Rigid panels

C. Exterior Walls
   1. Batt
   2. Foamed (spray or injected)
   3. Rigid panels
   4. Pour-in
   5. Insulated sheathing

D. Roof
   1. Batt and blankets
   2. Pour-in, blow-in
   3. Rigid panels

E. Piping and ducts
   1. Hot water pipes
   2. Supply air ducts

F. Window coverings
   1. Insulated shutters
   2. Shades
   3. Curtains - space blankets



3. CONSTRUCTION METHODS

A. Frame (wood and/or metal)
   1. Western platform
   2. Balloon
   3. Post and beam

B. Masonry
   1. Concrete masonry unit
   2. Brick veneer

C. Concrete
   1. Poured in place
   2. Precast

4. INFILTRATION

(NOTE: This concept is fully discussed in the Nebraska Energy Saving Manual, Section 2.)

A. Primary locations of infiltration
   1. Doors
      a. Between frame and structure
      b. Between door and frame
      c. Between door and threshold
   2. Windows
      a. Between frame and structure
      b. Between sash and frame
      c. Between glass, muntin and sash
   3. Walls - penetrations into living space
      a. Electrical outlets
      b. Pipes
      c. Flues w/thimbles
      d. Vent stacks

B. Cracks (exterior)
   1. Siding and soffit
   2. Joints in siding
   3. Joints in sheathing
   4. Masonry and siding
   5. Additions to existing structure
   6. Siding to exposed structural members
   7. Door casing and siding
   8. Window casing and siding

C. Penetrations through the siding
   1. Exterior lighting fixtures and outlets
   2. Pipes and sill cocks
   3. Ventilation fan exhaust
   4. Dryer vent

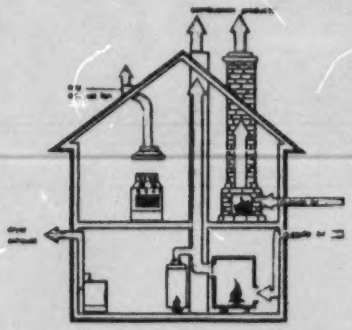
D. Contributing factors - Exhaust fans
   1. Kitchen range hood
   2. Bathroom exhaust fans

E. Combustion air
   1. Water heater (gas)
   2. Furnace (fossil fuel)
   3. Fireplace (damper not correctly closed when not in use)

F. Flues - undampered, open while not firing appliances
   1. Water heater (gas)
   2. Furnace (fossil fuel)

FIGURE TEN

APPLIANCES DRAWING AIR FROM THE HOUSE



5. METHODS OF DECREASING INFILTRATION

(NOTE: This concept is fully discussed in the Nebraska Energy Saving Manual, Section 3.)

A. Doors
   1. Caulking - frame and structure
   2. Weatherstrip - door and frame
   3. Threshold (interlocking, vinyl bulb, door shoe, sweeps, etc.)
   4. Automatic door closers (insure positive closure)

B. Windows
   1. Caulking - frame and structure
   2. Weatherstrip - sash and frame
   3. Glazing - with muntin and sash
   4. Storm windows - provide multiple glazing and block direct effects of the wind

C. Walls
   1. Penetrations - seal cracks around all penetrating objects (pipes, electrical wiring, etc.)
   2. Electrical outlets and switches - install foam seals under cover plates.

D. Foundation
   1. Cracks - fill extra wide cracks (where the house meets the foundation) with oakum, glass fiber insulation strips, etc.)
   2. Construction joints - seal all joints
   3. Sill connection - seal between foundation and frames

E. Other
   1. Exhaust fans - require the installation of a positive closing damper and operate it conscientiously!
   2. Dryer vent - install a positive closing damper
   3. Exhaust dampers
      a. Furnace (bi-metallic flue damper installation)
      b. Water heater (bi-metallic flue damper installation)
   4. Combustion air - duct exterior air to the point of combustion and provide for positive closure when not in use. This is especially true for fireplaces!

6. MOISTURE CONTROL

A. Problem areas
   1. Exterior walls
   2. Ceiling
   3. Foundation walls

B. Ways to control
   1. Vapor Barriers
      a. Walls - place the barrier on the inside (warm side) of exterior walls
      b. Ceiling - place the barrier on the inside (warm side)
      c. Slab on grade
      d. Crawl space

2. Ventilate
   a. Outside walls and ceiling
   b. Crawl space
   c. Gas appliances
   d. Exhaust fans (kitchen, bathroom, laundry, basement, attic)

3. Waterproofing
   a. Exterior foundation walls
   b. Roofing drainage

UNIT ACTIVITIES

1. The students should determine the types and amounts of insulation used in their homes (R-value, type) and make recommendations for change.

2. The student should revise his/her building plan or retrofit to reflect the energy saving measures discussed in this Unit.

UNIT REFERENCES

The following titles can be obtained from the:
Nebraska Energy Office
P.O. Box 95085
Lincoln, NE 68509

1. Nebraska Energy Saving Manual (50¢ per book)
2. How to Save Money by Insulating Your Home
3. Tips for Energy Savers
4. Energy Conservation with Windows
5. Superinsulation - A Housing Trend for the Eighties

Media (from the NEO)

16mm film: "All About Insulation" (15 minutes)

Slide sets: "The Ins and Outs of Insulation"
"Weatherization Slide Set"

Other References:

1. Weatherizing Your Home, by George Drake, Reston Publications.

UNIT V

ENERGY SAVING DEVICES AND METHODS

RATIONALE

The increasing cost of fossil fuels and electricity has prompted the development of several alternatives to traditional building and drafting practices. It will be the responsibility of professional builders and drafters to evaluate the cost/benefit ratio of new energy saving devices and methods. The purpose of this Unit is to explore several alternative technologies and discuss their potential effectiveness.

ADVANCED PREPARATION

It is recommended that the publications, "Energy Conservation with Windows," "The Passive Solar Story," "Solar Factsheets," and "Tips for Energy Savers" be obtained from the Nebraska Energy Office prior to beginning this Unit.

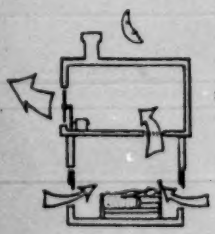
ANTICIPATED INSTRUCTIONAL TIME

1-3 weeks

UNIT GUIDE

1. VENTILATION

In the summer, the sun's heat adds a large radiant heat load to the air-conditioning system. This heat will build up and be stored even through a cool summer night. Radiant heat coupled with stored heat means high summer air-conditioning bills plus strain on all components of the air-conditioning system. Adequate ventilation of attic spaces can dramatically reduce both cost and component strain while cooling the home.



A. Attic Ventilation
   1. Fan-forced ventilation using thermostatic control
   2. Roof ventilate where no gable ends exist
   3. Eave vents

B. Windows Ventilation
   1. Size - windows should be large enough to provide adequate natural venting or should be equipped with a supplemental mechanical system. Specifications need to meet all applicable codes.
   2. Location - window area should be kept to a minimum on the north and west sides of the building.

C. Code Specifications
1. Most building codes for single and multiple family dwellings have a natural ventilation requirement. This normally implies about 5% of the floorspace area.

2. LIGHTING

A. Natural
1. Window and/or skylight size and location. Codes normally require 10% of the floorspace area.

B. Artificial
1. Fluorescent lights generate less heat than incandescent lights and use less energy.
2. Incorporate reflecting surfaces to properly light all room areas.

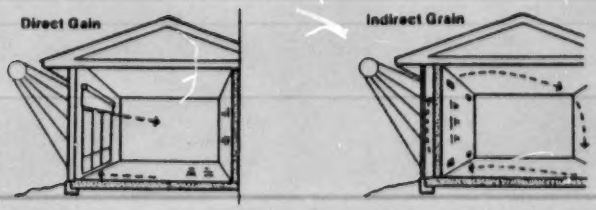
3. SOLAR SYSTEMS

A. Active Solar Systems - use a mechanical means to circulate the required conditioning (heating or cooling).

1. Hot water - solar collectors are used for heating or domestic hot water purposes. This type of solar system is most easily adapted for retrofit when a south facing roof or southern wall exposure is available.

2. Hot air - solar collectors are used for space heating. This type of solar system can be utilized for retrofit only if adequate storage capacity is available.
a. Daytime heating gain can be used directly without storage.
b. 30% to 50% of heating needs can be supplied by this method.

FIGURE ELEVEN

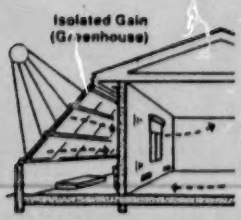


B. Other Solar Systems

1. Passive Solar - is readily adopted in the construction of new structures. The initial building costs are higher than conventional construction but the payback period is generally less than 10 years.

2. Direct Gain - space heating without a transfer from storage. This solar system utilizes a thermal mass incorporated into the walls and floors of the building.

3. Indirect Gain - direct heating of the thermal mass with subsequent radiation to the conditioned space. This solar system is well suited to both new construction and retrofitting.



4. Greenhouse Effect - a variation of direct and indirect gain systems. This solar system is also well suited to both new construction and retrofitting.

5. Thermal Storage - any medium used to store radiant heat. Heat is transferred to the room during non-sunshine hours.
   a. Water walls - designed into the structure; constructed of many different materials such as drums, pipes, etc.
   b. Trombe wall - a solid masonry or concrete wall placed directly behind the glazed (window) area.
   c. Rock storage pits - transfer of heat by circulating air (thermal siphoning).

4. STOVES AND FIREPLACES - WOOD BURNING

Stoves and fireplaces can be used as supplements or alternatives to traditional heating sources.

A. Types
   1. Free Standing
   2. Built-in

B. Ventilation
   1. Outside air should be available for combustion.
   2. Glass doors should be installed to prevent the loss of room heat, up the chimney.

C. Location
   1. The stove or fireplace should be placed away from the corner of a room or on an inside wall. Do not locate a fireplace on an outside wall. (NOTE: All fire safety regulations should be observed.)

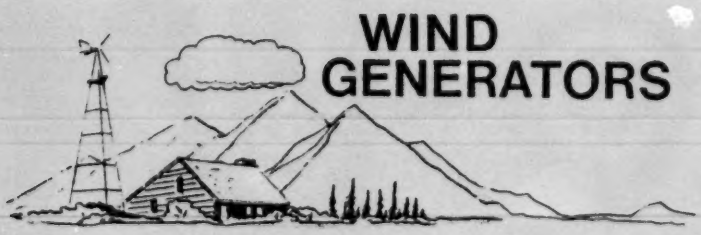
D. Chimneys
   1. Can be utilized for heat exchange or thermal mass storage if properly designed.
   2. Cleaning - stress the fact that chimney fires are caused by creosote accumulation and that chimneys should be periodically cleaned.

5. RESIDENTIAL ELECTRIC POWER GENERATION

A. Wind Generators
   1. Still in the experimental stages - very expensive at present
   2. Check with a testing center for efficiency ratings, durability, and cost/benefit ratio before purchasing or making a recommendation.

B. Photovoltaics
   1. Direct transfer of sunlight to electricity using solar cells.
   2. Photovoltaics are very expensive, at present, but research is being performed that may reduce their cost in the near future.

FIGURE TWELVE



6. HEAT SINKS

Heat sinks provide a method for utilizing the relatively constant temperature of the ground for purposes of heating and cooling.

A. Underground Culverts

B. Underground Water Lines
   1. Heat transfer occurs by using mechanical circulation methods.

7. MOVABLE INSULATION

This type of device involves the use of insulation to cover openings during a time period when heat transfer is being deferred from mass storage.

A. Expandable Solar Curtains

   1. Expandable solar curtains are utilized to cover solar collection windows and thus block heat transfer (heat loss).

B. Movable Insulating Shutters

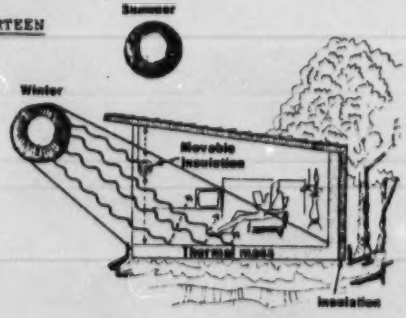
C. Bead Walls

   1. Bead walls are utilized to cover solar collection windows for insulation purposes.

D. Decorative Panels

   1. Insulation of exterior windows at night.

FIGURE THIRTEEN



UNIT ACTIVITIES

1. The student should research and report the latest innovations and advancements made for one of the energy saving methods discussed in this Unit.

2. The student should be able to categorize each energy saving method or device as to whether it offers practical savings at present or offers potential savings in the future.

UNIT REFERENCES

The following titles can be obtained from the:
Nebraska Energy Office
P.O. Box 95085
Lincoln, NE 68509

1. Nebraska Energy Saving Manual (50¢ per book)
2. Energy Conservation with Windows
3. Window Treatments for Energy Efficiency
4. Lighting
5. The Passive Solar Story
6. Solar Electricity from Photovoltaic Conversion
7. Passive Design : It's a Natural
8. Wood Stove Safety
9. Heating with Wood
10. What About Fireplaces?
11. Energy from the Winds
12. Energy Conservation with Heat Pumps
13. Insulation
14. Window Materials

Media (from the NEO)

3/4" Video: "Run With the Sun"

16mm Film: "The Power to Change"
"Solar Energy - The Great Adventure"

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